Chapter 5
A hierarchical model of the decision process

> All *intrinsic* properties of particular goods, those properties that make a diamond quite obviously something different from a loaf of bread, have been omitted from the theory [of consumer behaviour], so that a consumer who consumes diamonds alone is as rational as a consumer who consumes bread alone, but one who sometimes consumes bread, sometimes diamonds (*ceteris paribus* of course), is irrational.
> (Lancaster 1966, p. 132)

5.1 Theories dealing with bounded rationality

Another explanation of behaviour known as bounded rationality, which does not assume a maximising or optimising mechanism, has been developed and popularised in the economic literature by Simon (1955, 1959, 1979, 1990). This view recognises the information acquisition, storage, retrieval and processing limitations under which normal human decision makers operate. To cope with these limitations simplifying procedures are used to make decisions that often lead to different results from the maximising models. They may even lead to different results at different times depending upon which approximation is used at the time. Rationality of decision makers is assumed to be bounded by the limitations of their capabilities.

Recently Heiner (1983) proposed a theory of decision making under uncertainty, reliability theory, which incorporates some of Simon's ideas and findings. It is discussed in this chapter because it provides a useful conceptual framework in which to consider some effects of the Reserve Price Scheme on decisions by wool producers.

Apart from theories of decision making found in the economics literature, an extensive range of theories can be found in the consumer and psychological literature concerning the means by which people choose between the host of alternatives that arise in their day to day life. Much of this literature contains models that incorporate

people's mental limitations and the influence of context on decisions. Of these theories the hierarchical decision model (Gladwin 1977) was found the most appropriate for this study. In the remainder of the chapter its strengths and weaknesses and the reasons for choosing it are discussed.

5.1.1 Reliability theory

Heiner (1983) suggests reliability theory provides an explanation for rule-governed behaviour and simplifying heuristics that decrease the number of options considered and carried out by a decision maker. It models the effect of the gap between a decision maker's competence and the difficulty of a decision (the C-D gap) on the decision process.

To define reliability theory let the sets S and A represent, respectively, the possible states of the world and the decision maker's repertoire of actions. For each action $a \in A$ let S_a denote those states for which a is the best choice, or in other words, the 'right' conditions in which to select a. This means that if any of the states S_a occurs, a is the action that maximises utility. Conversely, the 'wrong' conditions for selecting a lead to lower performance and can be represented by $S - S_a$. The probability that the right conditions for selecting a will occur, $p(S_a) = \pi_a$, and therefore the probability that a will be selected under the wrong conditions, $p(S - S_a) = 1 - \pi_a$. The conditional probability that the decision maker will select action a when the right conditions S_a occur is given by $r_a = p(a|S_a)$. This results in a gain in performance g_a over sticking with the initial repertoire. Similarly $w_a = p(a|S - S_a)$ is the probability that a will be selected when the wrong conditions occur and l_a is the loss in performance from selecting a in these circumstances.

Using the above definitions Heiner (1983) develops the reliability condition:

$$\frac{r_a}{w_a} > \frac{l_a}{g_a} * \frac{1 - \pi_a}{\pi_a} = T_a, \qquad 5.1$$

which determines when the selection of a particular action will be sufficiently reliable for the decision maker to benefit from allowing the flexibility for selecting that action. The left-hand ratio, known as the reliability ratio, measures the relative

likelihood of selecting action a under optimal rather than non-optimal states. The reliability ratio must be greater than the right-hand side of the inequality, known as the tolerance limit T_a, for the reliability condition to be met. An important determinant of the size of T_a and therefore of the size of the required reliability ratio, is π_a. As π_a decreases the decision maker has to be more reliable in selecting the right conditions for a (Heiner 1983).

Several implications arise from consideration by a decision maker of the consequences of a C-D gap and the reliability condition. One is a decision maker will ignore actions that would be 'optimal' in only a few situations and consider only those actions that are likely to occur (Heiner 1983). Rigidity is introduced into the system and the variety of options considered decreases. This result is similar to those obtained in signal detection experiments and implies some signals and information will be ignored because the decision maker is unable to interpret the stimuli reliably (Heiner 1986).

Second, the greater the degree of uncertainty in the environment, the wider the C-D gap becomes and the chances of recognising the correct conditions for selecting particular actions are lower. This decreases the reliability ratios of particular actions, some to below the tolerance level. Therefore, greater uncertainty will lead to more rule governed and predictable behaviour, and is therefore the source of empirical regularities (Heiner 1983). Interestingly this leads to essentially the same conclusions as does the Emery and Trist (1965) analysis of management strategies appropriate for 'turbulent field' environments. In an application of this theory to Australian agriculture, Wright (1986) suggests farmers should focus on 'maximising operational efficiency for the chosen enterprise mix' (p. 47) and that 'the organisationally rational focus for planning of on-farm behaviour is the maximisation of resilience to the consequences of inevitable allocative inefficiency' (p. 48).

Heiner (1986) suggests a further implication of the theory for short and long-run supply behaviour. Short-run adjustments in supply occur when flexible inputs are changed and inflexible inputs are kept constant. Here the reliability condition has to be greater than the tolerance limit for only a short time into the future. For long-run

adjustments in supply, these inflexible inputs are adjusted. Since more of the future has to be considered when adjusting inflexible inputs, uncertainty is greater. The reliability ratio decreases and possibly the tolerance limit increases. Therefore long-run supply adjustment will require more durable changes, such as price increases (for instance). If price increases are perceived to be certain, then a larger supply response will result than for increases that may be quickly reversed. In the former instance long-run (or inflexible) inputs will increase by more than in the latter case where a short-run response is more likely. A floor price scheme or reserve price scheme is therefore likely to make long-run supply response more elastic by increasing the long-run reliability conditions. This is not just a price effect but is a 'reliability' effect or, in other terminology, a reduction in ambiguity effect. People are more likely to bet when probabilities are less ambiguous.

Heiner (1985, 1988) extends the model by considering the difference between imperfect information and using information imperfectly. Reliability is decomposed into two stages: the observation of information in the environment and the final behaviour based on the information observed. The conclusion from this is that as an environment becomes more complex, the messages that will enable prediction of changes will become more complex. Decision makers' ability to interpret the messages correctly will decline, leading to a reduction in reliability. In an extremely volatile and uncertain environment the optimal strategies may be ones that are rigid and allow response only to simple messages. Heiner (1985) suggests decision makers may not respond to costless information in such a situation, yet respond to less reliable sources because they are easier to interpret.

Given decision makers learn from their experiences, they will become more reliable at using some forms of 'local' information with which they have intimate knowledge and conversely be less reliable at using other 'non-local' sources of information. For example, farmers will attend closely to 'local' information about markets for their products, but will largely ignore information about exchange and interest rate forecasts. Actions of decision makers based on 'local' information will be chosen more reliably. Their limited processing abilities also mean that they do not have the opportunity to develop expertise in other 'non-local' information sources. Very few

will attempt, for instance, to incorporate information about expected exchange rate fluctuations in their marketing and production decisions. Much of this information will be ignored since they cannot use it reliably and decision makers will concentrate on information that they can use reliably.

What is more, Heiner's model implies this is probably the best option for most farmers since, beyond a certain point, using more complex and non-local information will decrease performance even if this information is free. Note the affinity of this with Simon's satisficing hypothesis and the implications of Emery and Trist's model of business environments.

Apart from the unsuccessful attempt by Bookstaber and Langsam (1985) to reformulate reliability theory in the expected utility framework, the major question about the validity of the theory has been raised by Driver (1992). It concerns the requirement for another reliability condition to be met before agents would benefit from including *a* in their behavioural repertoire. Another criticism by Hoen (1988) is that the theory does not offer a solution to Knightian uncertainty or the case of ignorance. While it is true reliability theory does not directly address these two issues, it could be handled conceptually by the model.

From the viewpoint of the questions to be studied in this thesis, the problem with reliability theory is, at this stage, it is a conceptual model rather than an empirical model. As Hoen (1988, p. 1119) says 'A central difficulty in interpreting reliability theory is that Heiner is not clear regarding the level at which it applies to human behavior.' Taken at its face value, the model is too complex to be a descriptive model of choice behaviour. The use of probabilities at the level assumed by SEU theory is debatable. If interpreted literally, the reliability theory equation extends this further. To counter this Heiner (1988) says decision makers are not assumed to know the probabilities mentioned in equation 5.1. At a purely conceptual level, though, it has intuitive appeal. Reliability theory can be considered as a predictive model although, again, this is more at a conceptual level than at an empirical level. The problem is how to set up the reliability ratio if, as Heiner says, decision makers

do not know the probabilities. Here the model may be used to predict the direction of change, but not the size.

5.2 Multi-attribute choice models

From the review of literature on SEU and its associated theories in chapters three and four, several hypotheses about decision making received considerable support:

people use simplifying rules or heuristics for complex decisions;

different decisions may result from alternative formulations of a problem because of these simplifications, or sometimes because the formulation triggers different rules;

people do not rank alternatives holistically using a single index number;

people combine probabilities and payoffs in non-multiplicative ways and often incorporate other attributes in a decision;

outcome and probability uncertainty are important determinants of people's behaviour;

in some situations people may be reluctant to bet.

Decision rules have been developed which incorporate most if not all of the above characteristics. Reviews of these models can be found in Bettman (1979), Earl (1983, 1990) and Gensch and Javalgi (1987). Although the most popular forms of these models were evaluated for their suitability they are not discussed in detail in the thesis. A thorough analysis of EU theories was considered more important since they are preferred by most agricultural economists. Once this had been achieved discussion of multi-attribute choice models was curtailed to keep the thesis to a reasonable length.

They can be classified under three broad headings: compensatory, non-compensatory and hybrid (Earl 1988). In general the models contain an assumption that decision

makers consider more than one attribute of a particular option in making their choice. Each attribute may be given a weighting or ranking and compared against an aspiration level for the attribute.

To rank the options, compensatory models use some additive weighting system for the attributes of an option. By this means a poor performance on one attribute may be compensated for by a good performance on another attribute. Perhaps the most widely used of this form of models is the Fishbein and Ajzen expectancy-value model (Ajzen and Fishbein 1980).

Non-compensatory models, as the name implies, involve decision rules in which the performance of an option on a particular attribute is compared with a particular target or aspiration level. A good performance on one attribute will not necessarily compensate for a poor performance on another attribute. Examples of these rules are given by Bettman (1979) and Earl (1983). They include conjunctive rules, disjunctive rules, lexicographic and lexicographic semi-order (e.g., Tversky 1969; Fishburn 1974), sequential elimination, elimination by aspects (Tversky 1972), pretree (Tversky and Sattath 1979), and additive-difference rules (Tversky 1969).

Hybrid strategies involve a combination of rules in which, for example, a lexicographic rule may be used to reduce the number of alternatives to be considered to a manageable number after which a compensatory rule may be used to decide between the final group of alternatives (see Gensch (1987) for a review of these models).

5.3 Choice of decision model

In the introductory chapter (section 1.3) it was stated that the choice of model to use in this study was guided by beliefs that information would need to be collected on specific decisions that wool producers had made, and that the approach should as far as possible avoid introducing theoretical bias. Four other factors were considered. Three of them came from Smith, Clark and Cotton (1984, p. 191) who suggest a model of individual decision-making (DM) behaviour should satisfy three requirements:

1. Possess the ability to predict the DM behavior of a given individual in a relatively complex decision environment....
2. Possess the property of indicating relationships between an individual's behavior and an individual's representation of the world....
3. Not place unreasonable demands on computational resources during construction or use.

For the purposes of this study a further requirement was that the model could be aggregated in some manner to provide predictions for groups of people. The requirement that the model could predict the behaviour of a given individual in a complex decision environment was considered the most important of the above requirements, although the others were also considered necessary.

Single and multiple attribute utility models were not considered appropriate for the reasons outlined in chapters 3 and 4 and because they place unreasonable demands on peoples' computational resources. Reliability theory was rejected because suitable empirical techniques could not be developed. Since the evidence from the review of EU models showed people evaluated alternatives according to their performance on a range of attributes some form of multi-attribute model which met the criteria above was considered necessary.

While compensatory models often explain most of the variance it was felt they would place unreasonable demands on decision makers for complex decisions. In such decisions they imply a single index number is derived for each alternative based on its performance on a range of attributes. In many farm decisions there is conceptually an infinite range of possible alternatives. Obviously not all these can be considered consciously (or even unconsciously). If it is also likely that people use simplifying rules for complex decisions then compensatory models may not accurately reflect an individual's representation of the world (see Gladwin H. 1975 for an illustration of this). Another aspect they handle poorly is that in some situations people may refuse to bet.

Although most non-compensatory models do not place unreasonable computational demands on people they assume a single rule is used for all decisions and for all parts of the decision. In addition good performance on one attribute may not compensate for poor performance on another attribute. For example, a higher

expected level of profit might not be allowed to compensate for greater variance (risk) of profit. The evidence from the literature (as summarised in 5.2) was that decision makers use more than one decision rule and some compensation may occur between attributes. Therefore non-compensatory models were eliminated because it was considered these issues would create errors in prediction and differences between an individual's behaviour and representation of the world.

This left the hybrid decision rules. Two potential models considered in this category were image theory (Beach and Mitchell 1987) and the hierarchical decision model (Gladwin 1977). The latter was chosen for this study mainly because image theory had only been tested in laboratory situations whereas the hierarchical decision model had been widely tested with farmer decisions. A related factor was that image theory with its different decision types and decision rules added additional complications to modelling the already complex array of decisions that contribute to the supply of wool.

It was recognised at the time, however, that difficulties would be experienced with the hierarchical decision model and that it might only be possible to model direction of change in livestock numbers and not the actual numbers themselves. It was hoped this problem could be overcome, but anyway it was counterbalanced by the descriptive power of the model.

5.4 The hierarchical decision model

The hierarchical decision model postulates a two-stage decision process. The first stage (which generally occurs fairly quickly), assumes decision makers narrow down the set of alternatives to a small subset by ensuring the options meet a set of criteria or aspects; a form of Tversky's (1972) elimination by aspects theory. Once the problem has been reduced to a choice between two or three alternatives, the 'hard-core' decision process of the second stage occurs. This stage is 'essentially an algebraic version of "maximization subject to constraints" ' (Gladwin 1976, p. 882).

Evidence from the SEU literature presented in chapters three and four showed that people may use different strategies for different decisions. A great deal more evidence for this can be found in the consumer and marketing literature (for evidence and reviews of this see Gensch (1987); Gensch and Javalgi (1987); and Paquette and Kida (1988)). In particular, many people appear to use two-stage processing strategies for decisions that involve several alternatives. It appears decision makers in this situation often simplify the problem by eliminating alternatives using a hierarchical, attribute-processing method such as elimination by aspects (Tversky 1972). When only a few alternatives remain, a more compensatory or detailed analysis is made of these.

A key assumption of the hierarchical decision model is that decisions are decomposed and involve the sequential comparison of the various alternatives based on a few characteristics or aspects. Each alternative is assumed to consist of a set of aspects (Gladwin 1980). Following the approach outlined by Lancaster (1966) and Tversky (1972), Gladwin (1977, p. 20) defines an aspect as 'a dimension or factor or feature of an alternative'. She also incorporates the definition of Tversky (1972, p. 285) who considers aspects:

> can represent values along some fixed quantitative or qualitative dimensions (e.g., price, quality, comfort) or they can be arbitrary features of the alternatives that do not fit into any simple dimensional structure.

In other words, when a farmer considers whether to increase his livestock numbers various aspects of this alternative will be considered; for example, relative expected future profitability, predictions of future carrying capacity, impact on cash flow, implications for labour requirements, and implications of worst case drought or price scenarios.

Gladwin further assumes all aspects are divided by the decision maker into a few discrete categories. A continuous aspect such as riskiness of a crop may be treated as a constraint (e.g., a farmer may say a particular crop is too risky to grow in his environmental conditions), or be used to establish an ordering (or a partial ordering) of the alternatives on the aspect (e.g., crop A less risky than crop B).

The hierarchical decision model has been used in several studies where it met the three requirements suggested by Smith et al. (1984) relatively well, while allowing some scope for aggregation. It has been used to model decisions about: choice of marketplace by fish sellers in Ghana (Gladwin C. 1975); choice of crops and adoption of new technology by farmers in Guatemala (Gladwin 1976); decisions by farmers in Alabama about the type and kind of chemical fertilisers to apply (Gladwin 1980); and adjustment decisions by tobacco producers in Florida following the collapse of their industry (Zabawa 1984).

Although the hierarchical decision models in the aforementioned studies were general models tested on groups of people, they could predict consistently 85 to 95 percent of the choices made by individuals. The models also proved useful in identifying the important reasons for particular decisions where expected utility and regression models were not successful. No unreasonable assumptions were made about the computational abilities of the decision makers involved since the models contained criteria identified by them. Perhaps the biggest weakness of the models was associated with problems of aggregation. While they were quite good at predicting individual and group decisions to change behaviour (especially to adopt), they were not so effective at predicting group decisions of the 'how much' type; for example, the quantity of fertiliser used, or area of crop planted.

The two stages of the hierarchical decision model are discussed in detail below.

5.4.1 Stage 1 - Pre-attentive or unconscious processing

In many situations decision makers are faced with choosing from a range of alternatives. An assumption of the hierarchical decision model is that their first step is to simplify the problem by rapidly, and often unconsciously, eliminating all alternatives that fail to pass a series of aspects. This stage is also referred to by Gladwin (1980) and Gladwin and Murtaugh (1980) as a pre-attentive process. By this they mean it refers to information processing which is 'outside of a decision maker's ordinary attention and awareness' (Gladwin and Murtaugh 1980, p. 117).

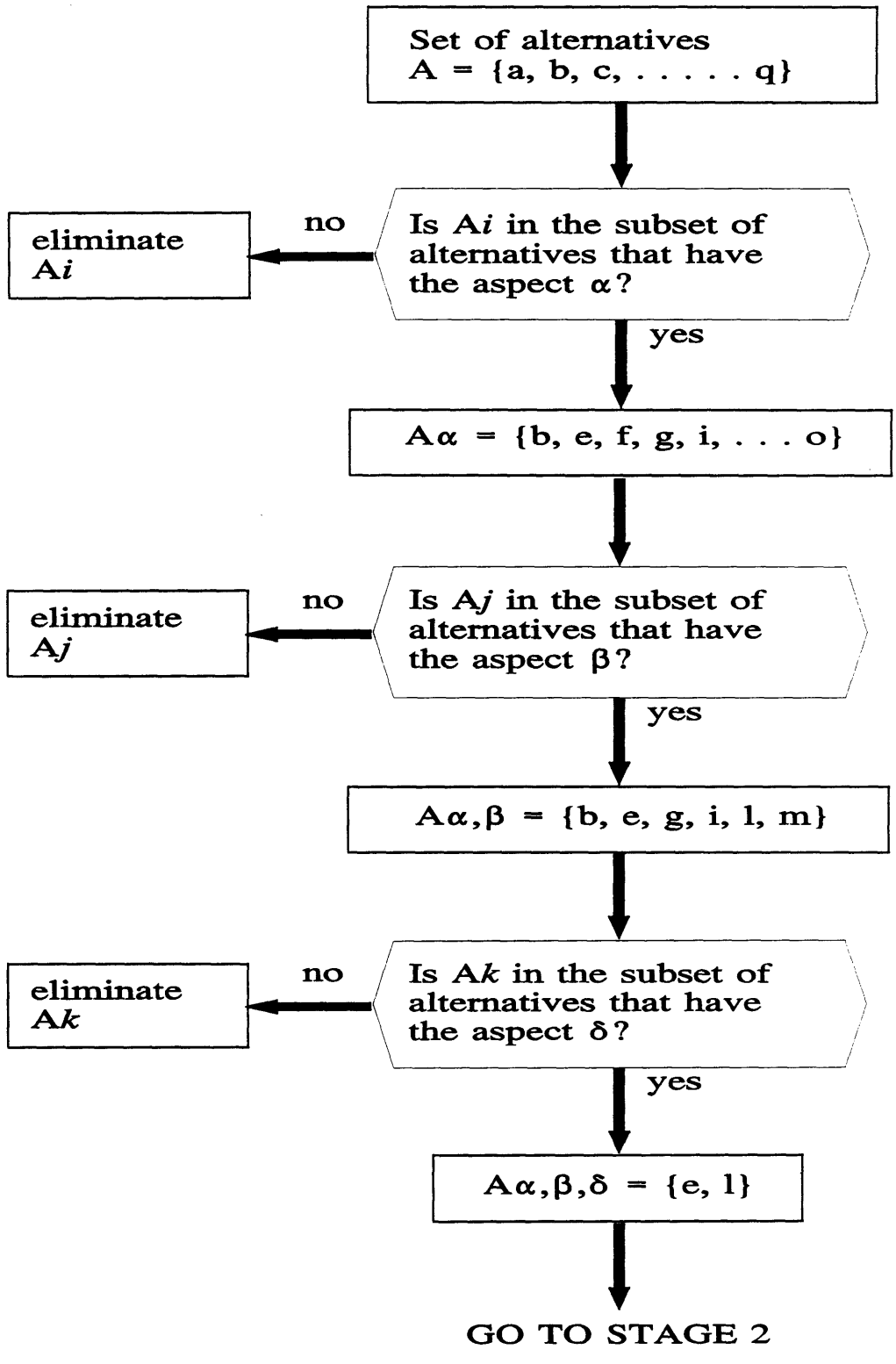
Pre-attentive processing involves the type of information filtering which we undertake almost unconsciously. For instance, when reading a list of papers to be presented at a conference, economists might scan the titles (and authors) looking for particular words that suggest the paper may be within their area of interest and mark these for further consideration. Alternatively, a wool producer may look at a mob of sheep while driving past and spot a number that are flyblown without being conscious of looking for them, whereas laymen would not be aware they were flyblown until shown the maggots.

This type of processing is illustrated in Figure 5.1. An initial set of alternatives is simplified by comparing them with a series of aspects. Stage 1 is assumed to continue until three or fewer alternatives remain; the number remaining depending on the type of decision. Three alternatives were chosen by Gladwin based on empirical observation rather than for any theoretical reason. The remaining alternatives are then compared in more detail in stage 2 of the decision process. For some decisions only one alternative may be left after the first stage and no further action is required. For other decisions none of the alternatives might pass, in which case the aspects may need to be reconsidered, or other actions considered.

This approach embodies the philosophy of Herbert Simon's bounded rationality that people can only attend to a limited amount of information and have simplifying mechanisms or heuristics that enable them to cope with the overwhelming flood of information. These heuristics provide an initial definition of the problem and set it up for more detailed consideration in the second stage. Gladwin and Murtaugh (1980, p. 118) put this aptly when they said:

> Farmers proceed through the agricultural cycle as master players proceed through a chess game, using an extensive body of knowledge to define potential problems and alternative solutions at each point in the cycle. Farmers are not necessarily conscious of the criteria that determine possible courses of action and may appear to communicate very imprecisely about them.

Figure 5.1
Stage 1 processing in a hierarchical decision model



In another sense these pre-attentive processes may also constrain a decision maker's actions by eliminating profitable options. This is especially likely to occur when new situations arise. Promising alternatives may be overlooked because the decision processes have solidified.

Although stage 1 has been couched in terms of unconscious processing, it is assumed decision makers can recall the aspects they use to eliminate the various alternatives and the aspects can be put in a verbal form that can be used in a decision model (Gladwin and Murtaugh 1980). Decision makers may not mention these aspects under superficial questioning, but they can be elicited with careful interview techniques. For example, graziers in the New England may not mention why they do not grow crops, but are well aware of their reasons for not doing so. Similarly, the grazier who noticed the flyblown sheep could describe the characteristics he used to pick them out from the mob. If he mentioned that he 'had better go and have a closer look' at the mob of sheep, another wool producer in the car with him would know the reason without explanation.

Gladwin (1977) suggests stage 1 of the hierarchical decision model is essentially the same as Tversky's (1972) elimination by aspects theory. A major difference between stage 1 of the hierarchical decision model and the elimination by aspects model is that the latter assume the process continues until only one alternative remains. On the other hand Gladwin (1977), while admitting this may occur in some decision situations, maintains that for more infrequent, important decisions that require conscious thought, a subset of two or three alternatives will remain. Another difference is in the method suggested for selection of the aspects. This is discussed in 5.6

5.4.2 Stage 2 - Maximisation subject to constraints

After setting up the problem in the first stage, decision makers are then assumed to enter the conscious or 'hard core' phase of the decision process (Gladwin 1977). This involves ordering the remaining alternatives on one aspect and then passing the alternatives in order through the remaining set of constraints or aspects. If the alternative ranked highest on the ordering aspect passes through all the constraints, it

is accepted. If it is not, the 'second-best' alternative gets a chance. If none of the remaining alternatives passes the constraints, the decision maker uses another strategy. Stage 2 is divided into six steps (see Gladwin (1977) and Gladwin (1980) for a comprehensive discussion of the steps).

Step 1 - Listing of aspects. The remaining alternatives are considered and a mental list made of relevant aspects contained in at least one alternative.

Step 2 - Editing of aspects. Some listed aspects are edited out to simplify the decision. Gladwin (1980) suggests several possible reasons for this including where an aspect is of little subjective worth, or where the alternatives have equivalent (not noticeably different) values on an aspect.

Step 3a - Selection of 'ordering' aspect. An aspect that will be used to order the alternatives is selected by the decision maker from the subset remaining. Gladwin (1980) suggests the choice could be made based on the utility of the aspects or, alternatively, by using a choice function that does not require a rank ordering of aspects. Further discussion of this issue is left to later in this chapter.

Step 3b - Ordering of alternatives. Gladwin (1980) suggests the type of ordering will depend upon whether the alternatives are mutually exclusive. For mutually exclusive alternatives the 'ordering' aspect α may be used to create:

a) a total order, $\alpha_{x_1} \succ \alpha_{x_2} \succ \alpha_{x_3}$; or

b) a semiorder, $\alpha_{x_1} \succ\succ_\delta \alpha_{x_2} \succ\succ_\delta \alpha_{x_3}$; where $\alpha_{x_1} \succ\succ_\delta \alpha_{x_2}$, if and only if

$\alpha_{x_1} \succ \alpha_{x_2} + \delta$ and δ is a just noticeable difference.

For non mutually exclusive alternatives aspect α is used to partially order the alternatives as either:

a) $\alpha_{x_1} \succ \alpha_{x_2}$ *and* $\alpha_{x_3} \succ \alpha_{x_2}$; or

b) a semiorder, $\alpha_{x_1} \succ\succ_\delta \alpha_{x_2}$ *and* $\alpha_{x_3} \succ\succ_\delta \alpha_{x_2}$.

Step 4 - Framing of constraints. Gladwin (1977, 1980) assumes the remaining aspects listed by the decision maker and constraints imposed by the environment are framed as a minimum requirement that must be met by the selected alternative. Whereas some constraints may be formed from aspects imposed by the decision maker, others may be constraints derived from limited resources or previous decisions. Gladwin (1980) surmises the latter type may be taken account of unconsciously since they come from a farmer's intimate knowledge of his farm. For example, a wool producer will know only a certain number of lambs can be fattened because paddocks with good quality fodder are limited. On the other hand more fine wool lambs could be raised since they have less demanding requirements and a wider range of paddocks could be used. To this extent the number and type of constraints framed may vary with the alternative.

When the aspect is continuous, a threshold level is selected that the alternative is required to meet. Where the aspect is a qualitative feature then the alternative must have that feature to pass the constraint.

Step 5 - Passing through constraints. The alternative with the highest order in step 3b is passed through all the constraints (not necessarily in any particular order). To be accepted the alternative must pass all the constraints. If it does not, the next alternative in the order is considered and compared with its corresponding set of constraints and so on. When none of the alternatives pass all the constraints, the decision maker is assumed to go to step 6.

Gladwin (1977) shows the choice procedure outlined in step 5 to be an algebraic version of maximisation subject to constraints that can be represented by a decision tree, table, flowchart, or by a set of decision rules.

Step 6 - Alternative strategies. Since occasionally the ordered alternatives are not able to pass the constraints, an alternative strategy needs to be chosen in order for a

choice to be made. Gladwin (1977, 1980) takes no fixed position on the strategy people will use in this situation. She suggests several strategies could be used including: order on another aspect β; retain ordering aspect α but change the constraint set by decreasing threshold requirement(s) and/or eliminating constraint(s); select the highest ranked alternative on aspect α; and postpone the decision and look for new alternatives.

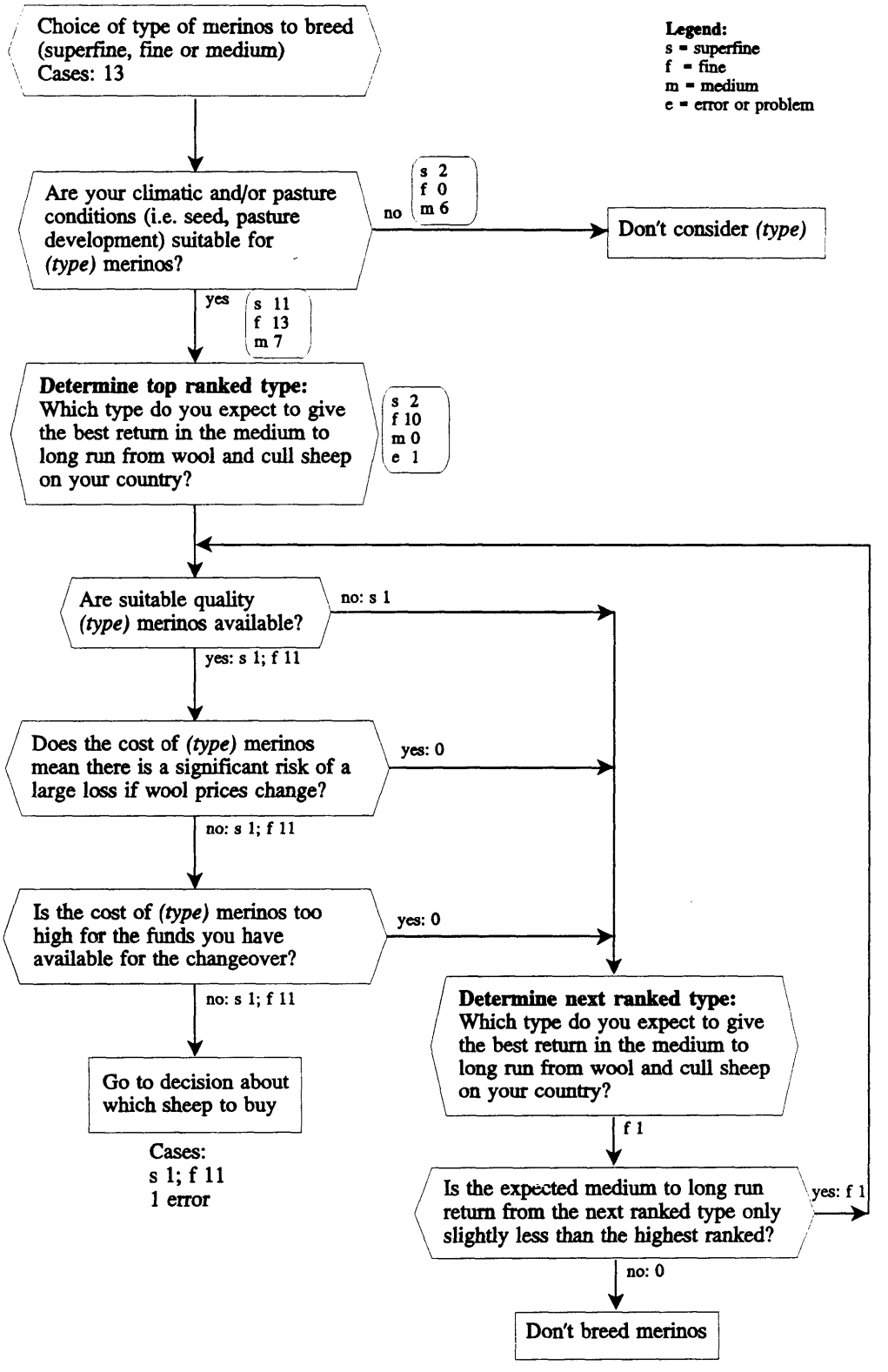
5.4.3 The decision process as a decision tree

A decision tree can represent the decision process. The decision-tree structure will depend upon the number of alternatives and constraints (see Gladwin (1977) for illustrations of many of these). In the decision-tree representation of the decision process, the aspects are formulated as criteria or constraints to assess the alternatives.

Figure 5.2 illustrates the formulation of a decision process as a decision tree. Apart from the first criterion, it also illustrates Stage 2 of this process. The figure illustrates one decision (choice of micron type of merino sheep), which is part of a series of decisions of a model to begin merino breeding. The criterion about climatic and pasture conditions is Stage 1 of the micron decision. Following this is the ordering aspect (Step 3b) which is the criterion used to decide the top ranked type of merino. Because the criteria are based on woolproducers' language they may not always correspond to the technically correct terminology from an economist's viewpoint. The remaining criteria are the constraints that the top ranked type is required to meet before it is accepted (Step 5). Note, in one case the top ranked type was not accepted because suitable quality sheep of this type were not available. Here the next ranked type was bought.

An important difference occurs between the use of criteria in stage 1 (elimination by aspects) and stage 2 (maximisation subject to constraints). In stage 1 a criterion is used to eliminate an alternative from further consideration. Conversely, the criterion used in step 3 of stage 2 is used to compare the alternatives, but not to eliminate them (Gladwin 1977). The alternatives with a lower ordering on a criterion still have a chance to be chosen if the higher ranked alternatives do not pass their constraints.

Figure 5.2
Decision about micron type of merino to breed



In addition, if none of the alternatives passes their constraints, they may get another chance in step 6.

5.5 Utility functions and the hierarchical decision model

While the decision trees of the hierarchical decision model represent decision rules that can be written in terms of preference relations, they do not represent a preference order. There is, therefore, no ordinal utility function of the alternatives (Gladwin C. 1975, 1977) because not all alternatives are compared and the ordering is not complete. This means it is also not transitive.

An outcome of this, which also applies to the elimination by aspects theory (Tversky 1972), is that the model may lead to violations of dominance. While this may create problems for a normative model of decision making, it does not create any particular problems for descriptive or predictive models provided they are consistent with the violations of dominance for the decisions being modelled. As noted by Tversky and Kahneman (1986), who provide evidence of such violations, a descriptive model needs to be able to provide an explanation for such phenomena.

Gladwin (1977) also examines the question of deriving a utility function of the alternatives based on the utility of an alternative being the sum of the utility of its aspects as assumed by Tversky (1972) for the elimination by aspects theory. She argues this implies a cardinal utility. This is not consistent with the rank ordering of aspects which implies an ordinal measure of utility. Since the additivity of utility assumption cannot be used, a utility function of alternatives cannot be derived in this way.

5.6 Selection of aspects in the hierarchical decision model

A key issue for a model that eliminates alternatives by aspects is the psychological mechanism used by decision makers for selecting aspects and for deciding their order. In his elimination by aspects model, Tversky (1972) follows the lead of

Lancaster (1966) and assumes that an individual derives utility from aspects of goods rather than the goods themselves. Therefore, each aspect can be assigned a number representing its utility or value.

In the elimination by aspects model the utility of a particular aspect α determines the probability of it being selected. The probability of aspect α being selected is given by:

$$P(\alpha \text{ is selected}) = \frac{u(\alpha)}{\sum_{\beta \in (A' - A^{\circ})} u(\beta)}, \qquad 5.2$$

where $u(\cdot)$ is the utility assigned to aspect $(\cdot)$ and aspects α and β belong to at least one alternative in A but not to all the alternatives (Gladwin 1980, p. 54). Here $\beta \in (A'-A^{\circ})$, where $A'-A^{\circ} = \{\alpha \mid \alpha \in x' \text{ for some but not all } x \in A\}$.

The aspects chosen and their order is therefore decided probabilistically. For a particular decision at time t the order of aspects is fixed. For repeat decisions over time the probabilistic process results in different states of mind, different orders of aspects and therefore different choices (Tversky 1972).

While Gladwin (1977) has argued that the hierarchical decision trees of stage 2 do not generate a utility function of aspects, it is also debatable whether people select aspects probabilistically. Gladwin C. (1975, 1977) and Zabawa (1984) provide evidence against this by obtaining different results in repeated decisions from a deterministic choice procedure. The differences occurred because in repeated decisions the alternatives received different assessments on the aspects. Many of these differences were due to changes in context rather than inconsistent behaviour.

Gladwin (1977) proposed three mechanisms by which a decision maker might select aspects without the need for rank ordering. They can be summarised as: subjective choice of the most important aspect without rank ordering the rest; some aspects may be constraints imposed from outside; and use decision rules to select the aspects. None of these imply a utility function over aspects.

The first mechanism, selection of aspects by subjective choice of the most important, is considered to result in a preference ordering for stage 1, but not stage 2. Gladwin (1977) argues that in stage 1 aspects will be picked in succession based on importance and this will result in an order of aspects. This seems inconsistent with her arguments that stage one is a pre-attentive or unconscious process. If an alternative is required to pass a series of aspects that are processed almost unconsciously there would be no requirement for any order of aspects to be made. In fact parallel processing could occur. Consider a wool producer on the New England tableland examining various enterprise options. Alternatives such as cotton, vegetables, wheat, and goats might be eliminated from further consideration because of a few aspects, without it being necessary to rank order the aspects. In stage 2, selection of the ordering aspect from the remaining set of aspects is required, but rank ordering of the others is not necessary since the alternatives have to pass all the aspects to be chosen.

The second mechanism is based on the idea that the decision maker has no choice with some constraints and therefore has no reason to rank order them. Constraints imposed by weather, capital and soil type may impose themselves without giving the decision maker any opportunity of avoiding them. Then the most that will occur is a partial ordering of the aspects.

It appears the choice mechanism considered most appropriate by Gladwin is the third which posits 'decision rules ... to select *aspects*, which then are used in other decision rules to select the alternatives.... rules behind the rules, or reasons behind the reasons' (Gladwin 1980, p. 55). The decision rules to select aspects may require aspects that choose between the various aspects used to choose between the alternatives of the decision process and so on.

This approach leads to the question of where the first set of rules comes from; the infinite regress problem. Gladwin (1977) suggests the rules arise from the schema a person has of the situation in which the choice arises. A schema is regarded as a mental image, internal representation or model of the universe (Gladwin 1977) which comes about because of experience (Gladwin 1979a).

In answering the inevitable question about where the schema comes from, Gladwin (1977) is less sure. She even goes as far as to suggest 'the way in which the decision criteria are selected is unimportant, as a test of the model will show incorrectly specified criteria' (Gladwin 1979b, p. 659) - shades of the Friedman defence. Schema are regarded as acquired along the lines suggested by Piaget (1970), but less concrete is the discussion of the motivation behind the use of schema. The latter is considered to be provided by a person's schema of themselves, their social identity (Gladwin 1977).

To answer the question of the source of self schema or social identity Gladwin (1977) toys with two ideas: a) personal motivation or 'utility'; and b) the Marxian concept of 'the superstructure of the social formation or system existing at a given time, ... the remnants of the superstructure of former social formations, and ... nuclei of superstructure of the future social system' (Gladwin 1977, p. 79). The first explanation is agreed to be circular. The second assumes mode of production is the basic explanation of all behaviour. No evidence is presented to support either of these explanations. Elsewhere she admits the decision criteria found from farmers in Mexico appear 'more amenable to a neoclassical-economic than a Marxist interpretation' (Gladwin 1979b, p. 659) which suggests using such a framework as the basis for explaining behaviour may not be appropriate either.

It is not the intention to debate Gladwin's explanations for the formation and motivation for use of schemata, since she does not appear to place great faith in them herself. This is a weakness of the model under criterion 2 (Smith et al. (1984) in 5.3). It does not provide an adequate explanation for why people might behave in the way suggested by the model, of the motivation for people's decisions, of how the aspects are selected, or of how learning might take place. In the next section a psychological theory known as personal construct theory (Kelly 1955) is introduced which overcomes this weakness and rounds out the theory.

5.7 Summary

The advantages of the hierarchical decision model are in its claims to being closer to the way in which people make decisions than the more traditional neoclassical and normative models. It can be criticised for being more difficult to apply to aggregated data and for not allowing tradeoffs between aspects. Another weakness is it does not adequately address the relationship between an individual's behaviour and their representation of the world. It is certain that the two-stage model of decisions is not the only method used by people to simplify their decision making. The main justification for its use is that the flexibility of its two stages allows it to approximate many approaches that research has shown to be applied commonly by decision makers. Another is that it has been particularly robust over a range of problems and cultures.

Chapter 6
Personal construct theory and a hierarchical decision model

> If you don't know what's wrong with a client, ask him; he may tell you!
> (Kelly 1955, p. 201)

6.1 Introduction

A major weakness of the hierarchical decision model outlined in the previous chapter was that it did not provide an adequate theoretical explanation of why people might behave in the manner suggested by the model. In this chapter a psychological theory of motivation and behaviour is introduced to overcome this weakness. Instead of assuming some form of utility framework as providing the motivation for human behaviour, people are viewed as trying to predict and control events - people as scientists - as outlined in personal construct theory by Kelly (1955). This view has much in common with the psychological theory of Piaget (see Lefrancois 1975), the 'satisficing' theory of Simon (1955) and models of choice in the mode of elimination by aspects (Tversky 1972).

As discussed earlier (see 3.19) utility theory and its various derivations can be criticised as 'black box' theories of human behaviour. Many studies (Payne 1976; Hogarth 1980; Payne, Bettman, Johnson 1988; Payne, Johnson, Bettman, Coupey 1990) have shown people use a variety of simplifying heuristics when making decisions and that the strategies used depend upon the complexity, time pressure and context of the decision. Personal construct theory is an attempt to outline some detail of the 'black box' and deals more directly with the strategies people use in making their decisions. It does not impose unrealistic expectations about people's information processing capacities.

In this chapter the assumptions of personal construct theory will be outlined and the manner in which the theory approximates the underlying motivation for behaviour emphasised. While personal construct theory is seen as providing the principal explanation for human behaviour, the operational model of people's decision processes to be used in this study is the hierarchical decision model outlined in the previous chapter. It is argued that personal construct theory provides a better explanation for the selection of aspects than those proposed by other authors. Finally, some advantages and criticisms of the personal-construct hierarchical decision model and the implications of its application to wool producers are examined.

6.2 Personal construct theory - the farmer as a scientist

The most common analogy used to explain, in simple terms, the philosophical position taken by Kelly (1955) and personal construct theorists is that people can be likened to scientists. They attempt to make sense of the world by developing hypotheses, or constructs, about how they expect the world can be anticipated to behave and continually test these constructs against what they construe has occurred. They are trying to make sense, discern patterns and establish order in the complexity of the world in which they find themselves. This approach puts the emphasis for the explanation of behaviour with the person. Although the environment influences behaviour, its effects are determined by the construction system of the individual.

To continue with the scientist analogy - scientists develop theories based on their existing belief structure, the patterns of evidence they see (which is viewed through their belief structure), and their perception of the environment in which they are operating. As mentioned by Quiggin (1986), when discussing expected utility theory, economic theories have a hard core of hypotheses that believers are very reluctant to abandon, but there are more loosely-held hypotheses which may be enhanced, adapted, or abandoned depending upon how the believers perceive the evidence for or against these hypotheses. Although an economist may not be particularly concerned about abandoning the outlying hypotheses, a different reaction is likely if the core hypotheses are attacked. In the latter situation a more violent reaction is likely, as anyone who has attended conferences or read journal debates will have noticed. Not

that all people will react in the same way or with the same vigour. Rather, personal construct theory assumes all people behave similarly in that they attempt to make sense of the world about them.

6.3 Structure of personal construct theory

Personal construct theory, unlike the utility theories, is not developed from axioms that can be used to develop a mathematical model of behaviour. Instead it is based on a fundamental postulate and 11 associated corollaries stated in abstract terms and give the theory a wide range of convenience (Bannister and Fransella 1971). It is not just a theory of risk, or a theory of choice, but depends upon the context to which it is applied to decide the content of the theory.

A complete listing of the postulate and corollaries of personal construct theory, along with a precise definition of the terms, can be found in Kelly (1955). For reasons of brevity those considered relevant to this study are outlined here with a brief interpretation of their meaning. The fundamental postulate (Kelly 1955, p. 46) is that:

> A person's processes are psychologically channelized by the ways in which he anticipates events.

This statement is saying that people's motivation and subsequent behaviour are directed by their expectations of the future and the manner in which their behaviours will interact with events in that future. It does not imply that what they do is in any sense completely decided, but it is structured in certain directions that affect the actions that will be undertaken. The emphasis on the future implies that what people are about is making sense out of their world and testing their view of it by how well it predicts (Bannister and Fransella 1971).

Eleven corollaries are added to this postulate to clarify and extend its interpretation. The construction corollary says:

> A person anticipates events by construing their replications.

People attempt to detect patterns or order in the surrounding chaos and interpretations are placed on the perceived patterns. For instance, in many families a baby or a young child rapidly learns that crying will induce parents and others to pick them up, cuddle them, or otherwise pay attention to them. Later in life they may find that this behaviour no longer has the desired effect, in which case they have to reconstruct events. When this first begins to occur, often at the arrival of another baby, it threatens their construct system and they may react against the change with anger, louder crying or hostility.

The corollary also implies a person's interpretation of events will depend upon the construction they placed upon them, or on the nature of the pattern they perceive. In this sense a construct is taken to be a 'way in which at least two elements are similar and contrast with a third' (Kelly 1955, p. 61) and covers concepts such as attitudes, beliefs, opinions and values (Bock 1976).

This leads to the individuality corollary which is:

> Persons differ from each other in their construction of events.

Peoples' construct systems will differ because they start with different abilities and experiences. As a result they may interpret new events in different ways. This may sound entirely obvious, but it has an important associated implication for theories that interpret people's motives from behaviour that occurs under seemingly similar situations. Although two people may behave in the same manner in a particular situation, they may do so for different reasons. Conversely, people with different experiences may still place the same construction on events.

In earlier chapters it was argued that people suffer from information processing limitations and therefore use simplifying heuristics that sometimes include hierarchical or sequential processing methods to handle complex decisions. A related idea can be found in personal construct theory with the organisation corollary:

> Each person characteristically evolves, for his convenience in anticipating events, a construction system embracing ordinal relationships between constructs.

The system of constructs is in the nature of a complex tree-like structure with some constructs subsuming others but bearing little relationship to still other constructs. In other words it is not a strict hierarchical arrangement of constructs (Earl 1983). Some constructs such as *buildings* have a higher level in the structure and a wider range of convenience than others such as *house* or *shed.* In this way events can be constructed at different levels allowing for differing interpretations depending upon the level of construction used.

Apart from the simple example of categorisation of objects given above, a hierarchical arrangement of constructs can also be applied to conflict-resolving or decision-making situations (Bannister and Fransella 1971). It implies the greatest consideration will be given to an alternative's position with respect to the 'higher' level constructs and that 'lower' level constructs may be ignored or given less emphasis if they conflict with the 'higher' level. A system of constructs such as this is consistent with the experimental results mentioned in previous chapters that suggest people use simplifying heuristics and sequential processing methods when making many types of decisions.

Kelly (1955) expands the definition of constructs with the dichotomy corollary:

> A person's construction system is composed of a finite series of dichotomous constructs.

In other words constructs can be considered as if they were bipolar (Bannister and Fransella 1971). Alternatives can be compared using these constructs based on whether they are similar or contrasting on each construct. Kelly (1955) also suggests some constructs allow gradations between the two extremes of similarity and contrast. A person uses a finite number of constructs, but the number and type will vary with factors such as their level of ability and intelligence, the type of decision and the decision-making environment.

The manner in which people make choices with their construct system is clarified by the choice corollary:

> A person chooses for himself that alternative in a dichotomised construct through which he anticipates the greater possibility for extension and definition of his system.

People choose alternatives that they expect will enable them to make sense of the world and cope with its complexities. This may range from choosing adventurous alternatives that provide new experiences and excitement, to opting out completely by committing suicide. Nothing in the above suggests the decision chosen is the best in retrospect, only that it seemed the best at the time the decision was taken. Nor does it imply that the person will be optimising in any rational sense according to the normal economic meanings for 'rational'. To some observers the behaviour may appear totally bizarre. The position of a person making a choice is described by Earl (1983, p. 126) when he says:

> The inquiring person also needs to bear in mind that the consequences of certain choices may put her in situations where she is forced to form theories about events which she is poorly equipped to analyse. She will avoid making such choices unless they seem to be necessary in order that she may obtain answers to questions that she finds particularly fascinating, or in order to keep still more incomprehensible situations and events at bay.

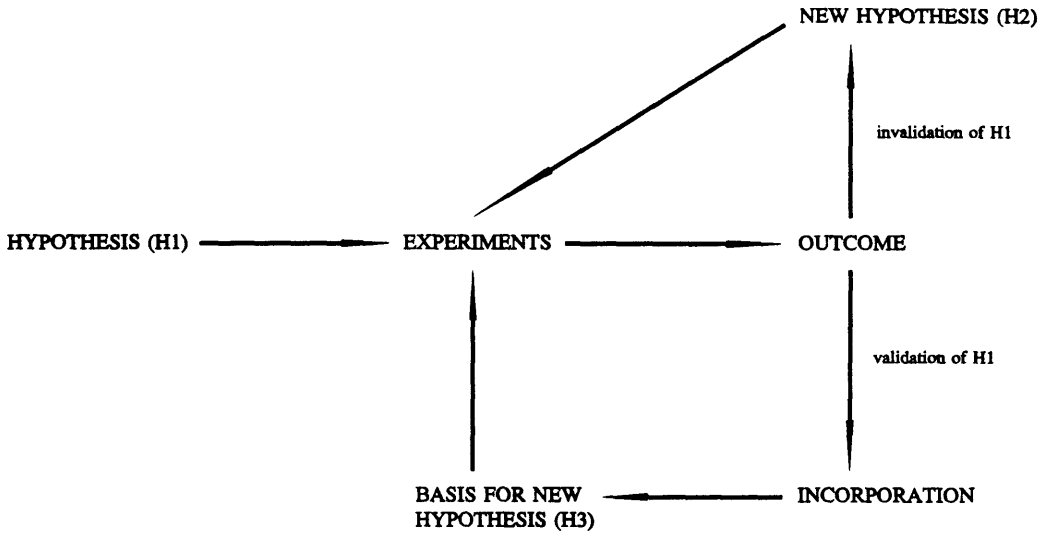
Kelly's theory is therefore a theory of motivation as well as a theory of behaviour. A person's motivation comes from the desire to be able to predict and control their interaction with the world around them. The actions they choose are directed by the way their construction system expects events to occur in the future.

Personal construct theory can also provide an explanation for learning with the addition of the experience corollary:

> A person's construction system varies as he successively construes the replications of events.

A 'process of construing is a process of learning' (Salmon 1981a, p. 30). The continual comparison by a person of their construction of events with the subsequent results allows for an evaluation of the appropriateness of the system. Figure 6.1, borrowed from Dunnett (1988), implies that this is a continuous process. Unless a person totally ignores hypotheses that are obviously incorrect, this process of anticipation and comparison will lead to changes in the construct system in an endeavour to improve the accuracy of the anticipations. The reason for calling it the theory of 'man as a scientist' is now obvious.

Figure 6.1
The reconstruction process



Source: Dunnett, G. 1988, 'Myths, methods and technique' p. 12, in *Working with People: Clinical Uses of Personal Construct Theory*, ed. G. Dunnett, Routledge, London, pp. 1-16.

Kelly (1955) notes changes that occur in the construction system may not necessarily be good or stabilising. Some may lead to greater accuracy, in which case the system will be more resistant to change. Earl (1983) suggests learning or changes in a person's construction system occur in three main ways: the positioning of a particular event may be changed with respect to the construct axes; the hierarchical position of constructs may be changed; and new constructs may be added.

A key assumption of personal construct theory is that people's behaviour may not always appear logical or rational to an outside observer (according to normal economic definitions of these terms), although it will be consistent with the constructs being applied by the person involved. The fragmentation corollary provides some reasoning behind this:

> A person may successively employ a variety of construction subsystems which are inferentially incompatible with each other.

Here Kelly (1955) is saying people may apply different construction subsystems to seemingly similar situations. The constructs contained within these subsystems do not necessarily have to be logically related to each other. Constructs at separate levels of the system and along different branches may be used. These may result in disparate behaviours.

While Kelly recognised people would be individuals in the sense that their construct systems would differ, to be consistent with his dichotomous construct system he was also aware that various groups of people would construe events in similar ways, implying similar construct systems. This is outlined in the commonality corollary:

> To the extent that one person employs a construction of experience which is similar to that employed by another, his psychological processes are similar to those of the other person.

This has the interesting implication that in situations in which a group of people have similar construct systems they may behave in similar ways. It is not assumed that individuals have to have the same experience to develop similar construct systems, only that, because of their various experiences, they have come to the same hypotheses about the results of various actions. It is therefore consistent for people with different experiences to act alike because they construe the situation in the same way.

6.4 Implications of personal construct theory for woolgrowers' decisions

Production and marketing decisions made by woolgrowers may be considered in the personal construct theory framework as motivated and directed by their construction of future events. Each woolgrower's construct system will have been developed over their lifetime. It will consist of components derived from the construction they have placed upon their experiences, including those that may have been passed along to them by their relatives and neighbours. To this extent their decisions will be influenced not only by recent experience, but possibly by experience stretching back through generations. Their construct systems will also be changing because of new experiences such as the recent dramatic downturn in the wool market and the subsequent lowering and scrapping of the floor price.

To understand the reasons for woolgrowers' decisions and how they are likely to react to future changes, personal construct theory implies that it is important to gain an understanding of the constructs that they use to make the decisions. Constructs may change in the future. Change will often be slow, but crises are likely to lead to dramatic changes in many woolgrowers' construct systems. Such changes are likely to create particular problems for econometric models since they may be points of structural change for the models, requiring time before enough periods are available to allow reassessment of coefficients. On the other hand, a model based on the principles of personal construct theory would require a reassessment of the constructs being used to make particular decisions, but this could be undertaken at the time of the decisions.

While the processing limitations of the human brain and their implications have been recognised as affecting the manner in which people make decisions (e.g., Simon and Newell 1971), personal construct theory adds a further dimension to this. Kelly recognised people use only a few constructs to make their decisions and that the constructs they use confine their anticipations of the future. Loasby (1986, p. 45) puts this well when he says:

> Kelly emphasises the significance of bounded rationality (though not under that name) both for the professional scientist and for the amateur scientist whom he wishes to study. Because the universe is presumed to be an integrated whole, any perception of it is inevitably partial and inaccurate; we can interpret it only with the aid of models of our own creation. These models cannot be derived from the phenomena by some natural principle of selection and adaptation, since an integrated universe embodies no such principles: they are human inventions. In a very important sense, scientific knowledge is not discovered, but created ....

This is entirely compatible with studies by MacCrimmon and Wehrung (1986) and Shapira (1986) who found business executives focus on just a couple of attributes of the decision even though information was available on more attributes. In situations of time or other pressure, not all the available constructs will be used, leading to further simplifications, with only the most relevant constructs being used. Therefore, descriptive and predictive models of wool producer behaviour cannot be based upon a normative type model, since a consistent set of rules is not followed.

Both Wright (1986) and Heiner (1988) use different theoretical approaches to suggest decision makers should and/or will react conservatively to changes in economic parameters. Wright (1986, p. 188) uses a business management framework to suggest farmers should concentrate on operational efficiency and select enterprises 'which can achieve positive gross margins more often than not'. The reliability theory of Heiner (1983) implies a similar result, with economic agents only considering an option when their average perceived gains from selecting the option are greater than the average losses. From a personal construct theory viewpoint this type of behaviour is explained by a person's ability to anticipate events (Earl 1983). Most people recognise their ability is limited (especially in turbulent situations) and since they are not inclined to be confronted continually with events that they cannot anticipate, they are likely to turn their attention to events for which they can provide an adequate construction. Their behaviour may therefore follow a regular pattern. Factors that may sometimes seem uneconomic will be stressed (e.g., topping the sale, or producing good quality feed) because these are events over which the farmer has some measure of control.

6.5 Eliciting construct systems

To use personal construct theory to model behaviour, the constructs that guide particular behaviours need to be elicited. Constructs can be obtained by many means ranging from informal conversation to formal computerised techniques. Dunnett (1988) divides the more formal techniques into two main types, those that compile a system of constructs and those based on starting with an individual construct. These techniques will be introduced briefly here since they can help obtain the aspects for a hierarchical decision model.

6.5.1 Methods for eliciting constructs

Dunnett (1988) discusses three methods for eliciting systems of constructs based on techniques originally outlined by Kelly (1955). These methods elicit many main constructs associated with the person's construction of the particular area of study. Two of these, self-characterisation and enactment, are most suited to clinical

psychology and will not be discussed here. The third is the repertory grid which is the technique used most widely for agricultural research.

The repertory grid technique

This technique (in its many forms) is based on the repertory test as outlined by Kelly (1955). It should be noted at the outset that the grid is not used exclusively by advocates of personal construct theory (Salmon 1981b), although they have used it extensively. Simply put, the repertory grid involves defining the particular area by means of various elements. In the original grids (Kelly 1955) the elements were different people, but researchers have used many types of elements including farm types (Ilbery and Hornby 1983) and crops (Briggs 1985). Subjects are then asked to specify various ways in which some elements are alike and some are different; this provides the constructs. Each element is rated or ranked on each construct. The result is a matrix that traditionally has the elements listed along the top and the constructs down the side.

A repertory grid matrix is a simplified portrayal of a person's construction of the particular area of interest being considered in the grid. The elements are the important options or alternatives within the particular area of interest, while the constructs are the main aspects used by the person when they compare and contrast the elements. The matrix can be analysed in various ways (e.g., factor analysis or cluster analysis) to provide alternative 'pictures' about the importance of the elicited constructs and the relationships between the elements.

As indicated earlier, the commonality corollary suggests that it is possible to combine grids to obtain a modal grid from a group of people. Techniques exist for achieving this but they are generally based on using standard sets of elements. In some situations standard sets of constructs may be used or, alternatively, standard sets of both elements and constructs are used.

6.5.2 Exploring individual constructs

Dunnett (1988) suggests that three main methods have been developed in this approach which start with an individual construct and explore its relationship with

associated constructs. These are laddering (Hinkle 1965), pyramiding (Landfield 1971) and the ABC approach (Tschudi 1977).

Laddering

As already suggested, personal construct theory envisages a hierarchical ordering of constructs from concrete (subordinate) constructs to more abstract (superordinate) constructs. Laddering is a method of eliciting more superordinate constructs from constructs already obtained. It can help elaborate a person's construct system, especially the abstract higher-order constructs.

Pyramiding

Pyramiding involves exploring a person's construct system in the opposite direction to laddering. More concrete constructs are obtained by inquiring about either or both of the poles of the original construct and establishing subordinate constructs that explain the original construct in more detail.

ABC approach

The aim of the ABC approach is to investigate the obstacles associated with a person moving from one pole of a construct to a seemingly more desirable pole (e.g., from smoking to not smoking). It explores the construction of the advantages and disadvantages of each pole of the original construct to improve understanding of why a change in behaviour may not be occurring.

6.6 Research using personal construct theory

While personal construct theory arose from Kelly's experience as a clinical psychologist, it has since been applied in a broad range of fields as a descriptive and predictive theory. Stewart and Stewart (1981) list a whole series of industrial uses including market research, quality control, questionnaire design, investigation of motivation and managerial effectiveness, training evaluation and counselling. It has been widely used in educational research into teaching and curriculum design (see, e.g., Postlethwaite and Jaspars 1986; Yorke 1987) and to investigate business lending decisions (e.g., Jankowicz and Hisrich 1987).

Several studies in Australia have used personal construct theory to investigate various agricultural issues such as: farm management behaviour (Salmon 1976); farmers' managerial strategies (Childs and Salmon 1978); acceptance of dairy practices (Hicks 1976); soil conservation practices (Brewin 1980); extension in the pig industry (Woog 1978); attitudes to sources of market information (Bock 1976; Whybrow and Diamond 1990); and information sources for the formulation of price expectations (Munro and Fisher 1982). Agricultural applications of the theory outside Australia include exploratory studies by Ilbery and Hornby (1983) of the factors influencing farmers' land-use decisions in Warwickshire, England and by Briggs (1985) of the main factors underlying farmers' choice of crops in Sudan.

Generally, the studies mentioned above use the repertory grid technique to elicit constructs associated with the particular problem. A range of analytical techniques was applied to the grid matrix and used to infer the importance of the constructs in deciding behaviour. Similar inferences were also made, when required, about the importance of the various elements; for example, in comparison of information sources.

While the studies have taken the first step of finding the main constructs people use in making their decisions, they have not taken the next step of using these constructs to directly predict decisions. Instead, the studies have stopped at the first step and inferred reasons for behaviour without setting up testable hypotheses about people's behaviour and subjecting them to the rigour of empirical tests. It could be argued, as Salmon (1981a, p. 37) does, that this is because 'construct theory does not predict behaviour, but rather it explores the reasons why the person behaves, given the environmental conditions'. In a pure sense this may be true, since the constructs a person uses in making a decision will be influenced by environmental conditions (before and at the time of the decision) in interaction with the person's cognitive processes. Despite this, the studies mentioned above suggest that people generally consider a relatively stable set of constructs when making particular decisions. It will be argued later in this thesis that these can be combined in various ways to make specific predictions about behaviour.

6.7 Some criticisms of personal construct theory

It can be argued that SEU theory (at least in its multi-attribute form) can be re-defined to cover the 'utility' to be gained from prediction and validation (Earl 1983). The utility or satisfaction we derive from our actions depends upon our expectations about what we expect will happen in interaction with what we perceive as happening. Therefore the constructs we apply to a particular situation are more important and useful in understanding and predicting behaviour than the utility or satisfaction we derive from the behaviour, since the latter will ultimately depend upon these constructs.

From a Kellian viewpoint, a concept of people deriving utility from actions does not add any significant benefits to the perspective of people as mainly concerned with making sense of the world in which they live. Multi-attribute utility is potentially hideously complex and difficult to measure, not to mention the questions already raised in earlier chapters about the descriptive validity of utility functions. As well, it does not have the same facility to explain changes in behaviour and learning. Personal construct theory also has an advantage as a descriptive theory over EU theories in that its assumptions and implied information processing requirements appear closer to reality.

An implication that might be drawn is that Kellian theory needs a separate concept of needs or drives to explain people's desire to predict and validate their world view. Why do they do anything? Consider, for example, the sex drive, or the desire to eat, as primitives that motivate behaviour and therefore are selected for and transmitted from one generation to the next through genes. If it is valid to consider these as motivating needs then it is also possible to argue that a drive to explore, predict and validate hypotheses about the environment is also an important survival mechanism which will be selected for, and transmitted between, generations. After all, an animal (or a society) which has superior drive and ability to predict the results of their behaviours is more likely to survive and therefore reproduce and expand its population.

Another view is that it is unnecessary to include an explanation 'for movement in a theory which makes movement its central assumption.' (Bannister and Fransella 1971, p. 19). This approach assumes life continues. Based on this assumption, the explanations derived from the theory provide an alternative construction of behaviour from other theories that postulate a 'force' compelling movement without necessarily denying the perspectives provided by these theories.

Earl (1983) has also raised the question of whether personal construct theory is unscientific because it is possible to rationalise all types of behaviour as constructs inside people's heads. It is true that people may individually rationalise their own behaviour by using particular construct systems, looking for confirming information and ignoring inconsistencies. From a research point of view, however, it is normally possible to discover the constructs people are using and hence external rationalisations for behaviour are not required. This compares favourably with the tendency for deviations from utility theory to be justified by post hoc explanations such as failure to take account of: attitude to risk; attitude to ambiguity; problems with the independence axiom; or the third moment of the subjective probability distribution of prices.

A further criticism has been that it is not possible to elicit all constructs. This fact was recognised by Kelly (1955, p. 51) who noted:

> A person's behavior may be based upon many interlocking equivalence-difference patterns which are never communicated in symbolic speech. Many of these preverbal or nonverbal governing constructs are embraced in the realm of physiology.

Other possible reasons for difficulty in eliciting the relevant constructs include: people may have difficulty in formulating priorities particularly in unfamiliar situations; and a person may not be willing to admit (even to themselves) the constructs they are using, because they may appear to conflict with higher level images they like to present of themselves (Earl 1983). A related issue is that it may be extremely difficult to capture the complex nature of a person's construction of particular events with a few verbal constructs. Many conflicting issues and emotions that are difficult to verbalise may be generated by the events. This is more likely to

occur when using the repertory grid technique since it constrains the expression of constructs.

Kelly (1955) was aware of these problems when expounding his theory, but saw them more as a problem of measurement and understanding for the interviewer than as a theoretical problem. From this viewpoint, its range of convenience is limited by our abilities, at present, to construe another person's system of constructs. This will introduce error in the system, with the importance of the error being decided by its effect on the descriptive and predictive ability of the theory in each particular case.

6.8 Personal construct theory and the hierarchical decision model

As discussed in the previous chapter, Gladwin (1977) saw a need to explain both how schemata were acquired and the motivation to use them when she attempted to explain the selection of aspects in terms of schemata. Since personal construct theory is a theory of motivation, a theory of learning and a theory of behaviour, it provides a coherent explanation for the selection of aspects in the hierarchical decision model.

6.8.1 Personal construct theory and the selection of aspects

From the viewpoint of a personal construct theorist, people construe the replication of events (construction corollary) using a hierarchical system (organisation corollary) of bipolar constructs (dichotomy corollary). Such a belief is consistent with the hierarchical decision model where aspects are considered bipolar in nature and to be arranged in a hierarchical system.

Aspects can be regarded as constructs, and people, acting as scientists, as choosing those aspects (constructs) which they believe will give them the best chance of predicting and controlling the environment in which they live. Since constructs do not have to be considered consciously (Kelly 1955), the theory is also consistent with selection of aspects in both the pre-attentive and conscious stages of Gladwin's model.

In this framework, constructs or aspects used in making decisions are chosen so that the alternative selected will allow the person to further extend and define their system (choice corollary). More significantly, the experience corollary implies the choice of constructs depends upon a person's perception of their experiences. In other words, the constructs a person uses to help in making a particular decision will be influenced by their perception of the current situation and experience with similar situations in the past. The context in which a person makes the decision is therefore important, as is their (not necessarily immediate) experience.

Tversky (1972) developed elimination by aspects theory in an attempt to explain behaviour that is often 'inconsistent, hierarchical and context dependent' (Tversky and Sattath 1979, p. 542). He explained the 'inconsistency' in terms of probabilistic choice of aspects. On the other hand, Gladwin (1979b) explained 'inconsistency' as the effect of different contexts on the relationship of alternatives to a set of aspects that remain constant. Personal construct theory explains apparent 'inconsistency' in terms of the latter reason plus two others: change in the hierarchical position of constructs; and the addition of new constructs (Earl 1983). Apparently 'inconsistent' behaviour may be explained by a person's use of a variety of construct systems that do not have to be logically related to each other (fragmentation corollary).

In his study of the collapse of the tobacco industry in Florida (using the hierarchical decision model), Zabawa (1984) used the concept of a routine, or script, to talk about the decision process farmers used when the industry had been stable over an extended period. Under these stable conditions farmers had developed a relatively consistent set of aspects or constructs to make their production and marketing decisions. In such situations most decisions were made unconsciously. When demand for their tobacco collapsed, the farmers were forced to develop a new set of aspects to help them decide between the various remaining alternatives. They could no longer rely on the old construct system and therefore had to pay more attention to their selection of aspects and the comparison of alternatives. Often, however, the farmers were inclined towards crops (such as tomatoes) which had similar production systems and therefore fitted in better with their previous scripts. Personal construct theory explains these occurrences as people being forced to reconstrue their farming

environment. In doing so they make use of previous constructs since these have proved useful in the past.

This example illustrates the pertinence of personal construct theory to a model that assumes alternatives are chosen by comparison of their performance on selected alternatives. It provides an explanation for the motivation behind their behaviour and for the choice of aspects used in the decision process.

6.8.2 Assumptions of a personal-construct hierarchical decision model

Personal construct theory has generally been used to infer reasons for behaviour rather than to predict particular decisions. No particular method of processing is assumed to be used by people when applying their construct systems to making decisions. Indeed, a variety of processing methods are consistent with personal construct theory (see the choice corollary and the fragmentation corollary).

Gladwin C. (1975, 1977) and Zabawa (1984) used deterministic tree models based on the hierarchical decision model to predict the decisions of groups of people. On the other hand, personal construct theory was developed to explain individual behaviour. To apply it to groups of people in the manner prescribed by the hierarchical decision model requires a few assumptions to be made.

First, members of the group are assumed to use similar constructs when making the particular decisions being studied; what Gladwin (1980) calls group-specific decision criteria. This implies a weaker version of the commonality corollary applies to all members of the group. Members would have to use essentially the same constructs to make the decisions but they would not have to reach the same conclusions or behave in the same way. In other words, the alternatives would be compared using the same group of aspects or constructs but the ratings of alternatives on each aspect could vary between people. For example, all members of a group of wool producers might compare fine wool sheep with prime lambs using a construct such as 'suitability of country for the enterprise', but might reach different conclusions, either because they have different country, or because they perceive their country to be different.

The validity of such an assumption is likely to increase with the length of stable environment the group of decision makers being studied has experienced. By this it is meant that the underlying climatic and institutional causes of variation in decision variables have remained the same. Such conditions are likely to allow the decision makers to have developed a stable set of constructs that their experience has shown enables them to cope with the variation. Decisions in such situations are guided by routines or scripts (Zabawa 1984). Dramatic changes in the environment, such as the collapse of the Reserve Price Scheme for wool, would require farmers to rethink their decision strategies and it might take some time for them to settle into a consistent pattern again. Meanwhile, wool producers might need to 'try out' a few systems before they could settle on a construction that provides satisfactory predictions of future events.

Second, certain assumptions are required about the hierarchical relationships between constructs of members of a group. The constructs used in stage 1 of the hierarchical decision model would need to be the same for all members of the group, but their order would not be important for the deterministic form of the model since alternatives that do not meet these aspects are eliminated. Similarly, in stage 2, all members of the group would be expected to order the remaining alternatives using the same aspect, but the other aspects or constraints would not have to be in any particular order.

This assumption is an extension of the first assumption, but together assumptions one and two are not particularly heroic. They are certainly entitled to be regarded as less heroic than assuming, for instance, that all farmers are utility maximisers (usually measured in monetary terms) and that they make calculations of the utility of each alternative when making their decisions. The constructs and their position in the model are elicited from the decision makers and are tested on their decisions, and therefore have the comforting advantage of being at least based in reality rather than being an imposed reality.

The third assumption is that for the decisions studied using a particular model, the order established by assumptions one and two remains constant. In other words,

constructs used in the decision process are not added or deleted from the system and their ordering, so far as it is required by assumption two, is not changed. It still allows the same alternatives to receive different ratings on particular constructs at different times. This is analogous to assuming there has been no structural change in an econometric model.

An assumption of no substantial change in the system is most likely to be valid when decision makers have been faced with a stable environment as discussed for assumption one. Anyhow, if the assumption is violated, it will rapidly become obvious when the predictive capacity of the model begins to decline. An advantage of the hierarchical decision model is that most of it is likely to remain robust to changes in the environment. When change does occur this may lead to additions, subtractions or changes to some aspects or constructs used by decision makers. The relative position of some constructs (and therefore their importance) may also change. Even so, large sections of the models are likely to remain unaffected by the changes. This occurs because people generally resist changes to their core constructs and make most changes at the margin (Kelly 1955).

As with any model that attempts to aggregate individual decisions, assumptions are made that are not completely realistic. Here, however, if there are few errors in prediction, farmers do not experience difficulties with the questions and no other issues seem important in the decisions then we can assume the assumptions are not too unrealistic in the situation being studied.

6.9 Advantages and criticisms of a personal-construct hierarchical decision model

Perhaps one of the most important advantages of combining personal construct theory and the hierarchical decision model is that it results in a descriptive model that is operational and can predict and analyse individual decisions. Although the theoretical underpinnings of the personal-construct hierarchical decision model involve a radical departure from elimination by aspects, at a functional level the two models are very similar. Anderson (1979) considered Gladwin C.'s (1975) study of

fish sellers to be an 'exemplary' example of the application of elimination by aspects to agriculture. In comparing various models of decision making under uncertainty, Anderson (1979) gives the elimination by aspects theory, and by implication the hierarchical decision model, a high ranking of appropriateness for most of the predictive and analytical purposes he defined.

Gladwin (1977, 1979b, 1980) discusses several other advantages of the hierarchical decision model. First, in most studies the model has proved remarkably accurate in predicting individual decisions, achieving rates of 85 to 95 per cent. It fulfils the first requirement, to predict in a complex decision environment, suggested by Smith et al. (1984). The model can also predict future decisions provided major changes do not occur in the conditions under which the decision makers operate.

Second, because it explicitly examines the aspects and constraints considered by decision makers, it is extremely useful for differentiating the main factors influencing their choices. This may be important information for formulation of policy, research and extension priorities.

As a descriptive and predictive model, another important advantage is that its psychological assumptions are much closer to the compartmentalised, heuristic processes people appear to use in making decisions. It contains a theory that opens the 'black box' and describes how decision makers construct their decision-making environment. This construction is used to build a model of their decision processes that can explain their behaviour. The model allows the use of both qualitative and quantitative decision criteria and does not require decision makers to make calculations or use information beyond the bounds of their abilities. A further advantage is it can allow and explain decisions that depart from 'economically rational' behaviour. In this respect the model also meets Smith et al. (1984) second and third requirements for models of individual decision making (see page 106).

Since decision trees are made up of sections based upon a person's construction of different facets of a particular decision (or series of decisions), they are easy to modify to account for errors in the model or for changes in a person's construction of

a particular facet. In these instances, errors can easily be pinpointed and most of the model will remain the same with only the appropriate part being altered. The models can therefore be adapted relatively easily to account for learning. Reasons for changes in behaviour which result from learning are apparent from the differences between the before and after models.

If a model is to be useful to policy makers and others who are concerned about the behaviour of groups of people rather than individuals, it must be applicable either to a group of people and the results aggregated, or be applicable, with accuracy, to aggregated data. The hierarchical decision model has proved particularly accurate at predicting adoption decisions (for admittedly restricted groups), but has been more patchy when applied to supply/demand type decisions. Gladwin C. (1975) successfully aggregated individual decisions of fish sellers to model the supply of fish to the marketplace. On the other hand, in her study of fertiliser decisions by farmers in Mexico she found 'the size of the increase seemed impossible to model' (Gladwin 1977, p. 179). The excuse in this situation was data and time limitations.

The personal-construct hierarchical decision model can be criticised on grounds relating to the selection of aspects and the effect of their position in the model on its accuracy and implications. Elicitation of constructs or aspects can be considered as a separate issue from the processing of constructs and so will be discussed separately here.

It is possible for constructs to be of a type that make it difficult for them to be expressed in a form that can be used in a decision tree. This can occur for at least two reasons: they are in some sense physiological and therefore not expressible in words; or there may not be appropriate verbal labels that can be used to explain the construction of certain events.

A further issue raised by Salmon (1981a) is that management constructs may be difficult to elicit fully because the decision maker may not be conscious of them unless he is placed in the position of making the decision. Under the hierarchical decision model, it could also be said that aspects considered in the pre-attentive phase

may be difficult to elicit. However, the pre-attentive phase for most farming decisions is likely to consist largely of the application of aspects that have become so familiar through experience that farmers no longer consider them consciously. In other words, these aspects were considered more actively in previous decisions. This implies it should be possible to elicit them.

Practical experience in eliciting aspects (e.g., Gladwin C. 1975, 1977; Zabawa 1984) has been that aspects used in the pre-attentive phase can be elicited and formulated as criteria that predict accurately in a decision tree. Although the aspects used in this stage may not be apparent from preliminary discussion, they can be obtained by probing. Anyhow, when they are left out it will become apparent because the model will fail to predict.

Gladwin (1977, 1979a) suggested that delineating between norms or beliefs and decision criteria can prove difficult. When this occurs the criteria will not predict behaviour. To overcome this she suggested finding people who had contrasting behaviour (i.e., used different behaviour for say different paddocks) despite holding a particular belief. Eliciting decision criteria is a case of attempting to 'walk in another person's moccasins' and requires the interviewer to have a thorough understanding of the decision maker's construction of events. Another possibility is to use the laddering and ABC techniques of personal construct psychology to explore statements that have failed to predict behaviour when tested. These techniques can increase understanding of superordinate, subordinate and associated constructs and can help the interviewer ask the questions required to elicit the appropriate aspects.

One problem with splitting the decision process into two stages, with different decision strategies in each stage, is to define the boundary between the stages. Gladwin (1980) recognises this problem by following the suggestion of Gladwin and Murtaugh (1980) to define the boundary at the point where the decision passes from pre-attentive to conscious thought. In reality this is not completely satisfactory since, for some decisions (probably less important ones), an elimination by aspects process will be used for the entire process. The decision maker may not be particularly conscious of the aspects used in the first part of the process but will be aware of

those used in the last part. To account for this, stage 2 of the hierarchical decision model can be considered as beginning when a decision maker is aware of making a conscious effort to choose among a few alternatives. In fact, Gladwin C. (1975, 1977) implicitly uses this idea when she justifies the addition of the second stage by rejecting the elimination by aspects model because it is incomplete when people are making difficult decisions that require consideration of competing aspects.

A criticism often made of decision-tree models is that they can lead to the selection of options that are inferior to alternatives that are eliminated. For a descriptive and predictive model, however, this is not a problem if these 'irrational' events are explained and predicted by the model. Rather, it is a requirement of a valid model.

A more relevant criticism is that the position of an aspect or criterion in the decision tree may influence the answer or, more importantly, may affect the perceived importance of the aspect as a limiting factor. Some aspects logically precede others and so do not create a problem. For others it is more problematic since they may not be ranked by importance either. If the model predicts behaviour accurately then the former criticism is not relevant. However, it is still possible that the order of aspects in the model may not reflect their relative importance in the decision. In the case where there is one new alternative that may be adopted or rejected the order of aspects does not affect the outcome (Gladwin 1977). However, it may influence the perceived importance of an aspect. This can be tested by changing the position of aspects and examining its effect on adoption. It requires a response from each decision maker, on all aspects in the tree, to be carried out.

From a neoclassical economist's viewpoint, perhaps the most important weakness of the model is that it does not allow for compensation and tradeoffs between aspects. They would argue that if aspects are considered by decision makers then a model of the form:

$$P(choosing\ A) = \sum_{i=1}^{n} \alpha_i \left[\begin{array}{c} evaluation\ of \\ A\ on\ aspect\ i \end{array} \right], \qquad 6.1$$

is appropriate. Here α_i represents the importance attached to aspect i of A and an evaluation of A on aspect i is considered in the general sense covering, for example, interaction terms. Such a model could then be estimated using regression analysis. It is an empirical question whether decision makers tradeoff between aspects when making particular decisions or whether they follow the non-compensatory approach of the hierarchical model. Both have some intuitive appeal, with tradeoffs being possible for the comparison of a couple of alternatives on two or three aspects, but being unlikely for more alternatives and aspects because of intellectual limitations.

In her study of fish sellers (Gladwin C. 1975) compared a tradeoff model with the decision-tree model using their decisions to go to a particular market. The result was 'that the tree model, ... predicts more decisions with more confidence than does a trade-off model' (Gladwin C. 1975, p. 111).

An interesting aside to this is a study by Gladwin H. (1975) which illustrates that regression models estimated using a linear additive decision model may appear to behave 'as if' they are describing and predicting the decision process. In the study the decision process was a hierarchical decision model simulated on a computer. However, despite sometimes highly 'significant' coefficients, the results of the regression distorted the importance of the contributing aspects. More seriously, the distortion increased with aggregated data so that the importance of the costs aspect was greatly exaggerated. It implied costs explained more of the variance than it did. The conclusion is that statistical significance or size of coefficients for aspects in regression equations does not necessarily show the behavioural importance of the aspect in the underlying decision processes.

Questions are therefore raised about the efficacy of the argument supporting additive type models on the basis that they describe aggregated behaviour when they are not descriptive of individual behaviour. Gladwin H. (1975) makes the further point that while the additive model may make accurate predictions, it depends on the under-

lying decision rules and parameters remaining constant. When these are disrupted it is not possible to say what the effect will be since the model does not explain the underlying process, only acts 'as if' it does.

6.10 Application of the personal-construct hierarchical decision model to woolgrower decisions

Following Kelly (1955), the personal-construct hierarchical decision model incorporates the view that if you want to know why someone is doing something you should ask them; they may tell you. Related to this is the assertion that people have valid reasons for doing what they do and that these can be elicited from them. Therefore, the researcher must go out into the field and collect specific information from woolgrowers about the reasons for their behaviour. These are the reasons used to build the models, rather than assumptions about behaviour thought to be relevant by a researcher sitting in an office and/or based on the results derived from fitting the latest functional form to a data series.

Since woolgrowers are assumed to compare alternatives using selected aspects appraised individually rather than in some holistic fashion, aspects are arrayed in discrete rather than continuous terms. Seasonal conditions, return of a crop, yields, etc. are remembered as ranges rather than continuous variables. Constraints are also formulated in the same manner. Responses of individual woolgrowers to changes in aspects (e.g., expected price) are therefore postulated to occur in discontinuousness rather than continuous fashion. Aggregation of responses may remove the discontinuities, but this is not certain. The implication is small changes in an aspect may have much lower elasticities of response than larger changes. This may depend on the context of the measurement of elasticity since recent history of the variable could influence the effect of a small change if, for example, the change has been in the same directions as previous changes (Wright and Kaine-Jones 1985).

Most of the decisions modelled by Gladwin C. (1975, 1977) and Zabawa (1984) are of the yes/no, adopt/not adopt type. On the other hand, many production and marketing decisions of woolgrowers require them to decide what level of change is

required as well as a decision to change or not (e.g., increase wool ewe numbers; by how much; and how). A sequence of decisions is implied. Moreover, the decisions need to be linked, and each decision may need to be modelled separately using different criteria and possibly include both stages 1 and 2.

As pointed out by Gladwin (1977, 1980), in stage 2, decision trees for adoption are simple, requiring just one branch on the tree. Where there are multiple alternatives and constraints the decision trees become more complex. To model a production problem requires the integration of a series of different trees with a range of complexities.

A further implication of the assumptions of the personal-construct hierarchical decision model is that a model developed for one region cannot, in general, be used in another region with different environmental and resource constraints. Although similar aspects may be used in many parts of the model, enough differences would exist to require a separate model to be developed. Within a region many parts of a model will not be relevant to some woolgrowers because they are eliminated in the decision process; however, the remaining parts should still be valid.

A major difference between this model and expected utility models of behaviour is that attitude to risk is not considered a stable measure that acts by increasing or decreasing the curvature of a utility function. Instead, different types of risk (e.g., risk of low prices and risk of drought) can be considered and taken account of separately by means of constraints on the decision process. Not only does this decrease the computational requirements for woolgrowers, it allows for the existence of different strategies to take account of the different types of risk.

6.11 Conclusion

In this chapter a model of behaviour has been outlined which has two main features: a theory of man as a scientist that explains the motivation and reasons for behaviour; and a hierarchical model of decision processes that outlines a method by which decisions can be predicted and explained. The personal-construct hierarchical

decision model is a descriptive and predictive model of behaviour that allows for the simplifying procedures people use in making their decisions. It also provides an explanation for learning and therefore for changes in behaviour.

Application of the personal-construct hierarchical decision model to production and marketing decisions of wool producers in the New England region is addressed in the remainder of the thesis.